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ARTICLE I.—*Studies of the Life History, Habits, and Taxonomic Relations of a New Species of Oberea (Oberea ulmicola Chittenden).* BY F. M. WEBSTER.

The species of this genus of *Cerambycidae* are not easy to define, on account of their variability in color, and they have for this reason been the subject of repeated and radical revision by entomologists. In 1878, Dr. G. H. Horn, in his revision of the genus* restricted the number of species to eleven, while Mr. Chas. W. Leng, eighteen years later, reduced this number to five. In this latter revision *Oberea tripunctata* Swederus was divided into two groups, or forms as they are there called, the *bimaculata* form and the *tripunctata* form, the species itself being thus burdened with no less than eleven synonyms. Even this arrangement is unsatisfactory, and considerable evidence has accumulated tending to show that we may have species the adults of which are difficult to separate, whose larvæ are restricted to very different food plants. Thus *Oberea bimaculata* has hitherto been reared exclusively from plants belonging to the genus *Rubus*, while *O. tripunctata* breeds in a variety of food plants other than *Rubus*, and including the elm. It is therefore interesting to find another apparently valid species which seems restricted to the elm, although *O. tripunctata*, as at present understood, breeds on the same tree with the one under consideration.

One of its close allies, *Oberea texana*, is a southern form, while *O. ulmicola* has thus far been found only in a single city of about 20,000 inhabitants in central Illinois. Even there it does not infest the elms of the entire city, but has confined itself to a certain section, within which it is so excessively abundant that the females are compelled to deposit their eggs in the same twigs again and again, notwithstanding the fact that only

*Trans. Am. Ent. Soc., Vol. VII., pp. 45-48.

†Loc. cit., Vol. XXIII., pp. 153-157.

a single larva can survive in each twig. This congestion in numbers and restricted distribution would commonly be taken to indicate a spirit of mutual toleration bordering on gregariousness. In this case, however, if adults of both sexes are confined at all closely together they will, regardless of sex, fall upon each other, amputating antennæ and legs with a savagery like that of the most bloodthirsty quadruped, and this vicious disposition is, in fact, one of the greatest obstacles to the close study of these insects in confinement.

These studies are based very largely on the acute and untiring observations of Mr. E. S. G. Titus, formerly Assistant to the State Entomologist of Illinois and now an assistant in the Division of Entomology of the United States Department of Agriculture. The species was from the first regarded by him as probably new, and later, in connection with my own studies of insects infesting shade and ornamental trees, specimens were submitted to Dr. L. O. Howard for identification, which revealed the fact that it was not represented in the collections of the Department of Agriculture, or in those of the United States National Museum. As Mr. F. H. Chittenden, of the Division of Entomology of the Department of Agriculture, had already collected considerable material for a study of the genus *Oberea*, he was invited to describe the species, and his description of the adult follows, together with a table prepared by him showing the relations of the species in the genus.

DESCRIPTION OF THE SPECIES.

The Adult.

"While studying reared material of the genus *Oberea*, and referring to published accounts of the species, it was observed that in many references to economic literature the raspberry cane-borer was called *Oberea tripunctata* Fabr. as well as *O. tripunctata* Swed. It has been conceded by Horn and others that the former name is synonymous with *O. bimaculata* Oliv., which, the writer is convinced, is quite distinct from *O. tripunctata* of Swederus. We have recently had considerable correspondence

with Prof. F. M. Webster, who has also reared these two species, as well as a third, and as his views correspond with the writer's, a table has been drawn up, after careful comparison of nearly a hundred examples of the first two species discussed and a lesser number of the third.

"As a preliminary, it should be stated that the writer fully concurs in the views expressed by Dr. Horn* when he stated that the table furnished at that time, 1878, although founded on color characters, attained 'the object in view as nearly as can be done'; also that the *species* were so variable, even with the suppression which he had made, 'as almost to resist generalization'.

"The first two forms considered can readily be distinguished by color characters alone, examination of all available material showing these colors of sufficient constancy to leave no doubt as to the specific identity of a single specimen. Moreover, the three species are physiologically distinct, being constant within certain limits as regarding habits, *O. bimaculata* having thus far been reared only from canes of raspberry and blackberry (*Rubus*), *O. tripunctata* from various deciduous trees, including dogwood (*Cornus*) and witch-hazel, while the third species is known only as inhabiting the elm (*Ulmus*). The three species now under discussion may be separated by the aid of the following table:

- A. Ventral surface (including legs and antennæ) except thorax, black; abdomen somewhat coarsely and very sparsely punctate, with rather long, black or dark brown pubescence.
 - Elytra with black pubescence, disc with prominent carinæ, and deeply and closely punctate.
 - Head somewhat strongly and densely punctate, with moderately black, brown, or dark yellow pubescence.....*bimaculata* Oliv.
- AA. Ventral surface (including legs) largely yellow; abdomen with punctuation feeble, obsolete, or wanting on some segments; pubescence short and pale.

**Loc. cit.*

Elytra with cinereous or griseous pubescence; disc more flattened, with less prominent carinae, less strongly punctate.

Head less strongly and more sparsely punctate, more strongly pubescent with gray or yellow.

a. Form slender, antennae long; head, antennae, and elytra mostly black, with cinereous pubescence; elytra moderately, finely, and sparsely punctate.....

ulmicola Chittn., n. sp.

aa. Form more robust, antennae shorter, black, or partly yellow; head with yellow or griseous pubescence; elytra largely yellow, more strongly and densely punctate, with very pale yellowish or griseous pubescence.

tripunctata Swed.

“*Oberca ulmicola* Chittenden, n. sp. (Pl. I., Fig. 1.)

“Form slender. Head, antennae, and elytra black, with gray pubescence, becoming long and dense on the head, nearly obscuring the punctures, and darker plumbeous-gray on the thorax. Antennae slender, long, five-sixths of the length of the entire insect. Head somewhat feebly and sparsely punctate, with strongly defined median line, especially in the posterior portion. Thorax yellow, callosities black, occasionally with a smaller black antescutellar spot on each side; just above the leg there is usually another variable black spot, either smaller or much larger than the others. Elytra with basal portion on each side of and including the scutellum, yellow, occasionally with a longitudinal yellow streak on each elytron, extending from the base nearly to the apex, which is emarginate and sub-bidentate; the surface comparatively sparsely and feebly punctate. Epipleurae yellow. Ventral surface usually yellow, but occasionally with a portion of the thorax and of the second and third abdominal segments and less frequently the first and last segment, black. Punctuation very shallow, nearly obsolete

on abdominal segments. Proximal portion of legs yellow, distal portion black. The sexual and other characters as far as observed differ but slightly from those of *tripunctata* and *bimaculata*.

Length, 9–13 mm.; width, 1.2–2.0 mm. Average length, 12 mm.; width, 1.9 mm. The small specimens are obviously stunted.

"Habitat, Decatur, Illinois, where it breeds in twigs of the American elm, *Ulmus americana*. Described from many specimens reared by Mr. E. S. G. Titus and collected by himself and Mr. Webster.

"Type, No. 6981, U. S. National Museum. Kindly presented by Dr. S. A. Forbes, Director of the Illinois State Laboratory of Natural History.

"This species has a somewhat strong resemblance, in dark individuals, to *O. bimaculata*, while the pale forms approach *O. tripunctata*. In reality it is nearer *O. terana* in appearance, but has longer antennæ than any of these. *O. terana* is quite distinct in having the paler parts, thorax, and ventral surface red, epipleuræ black, proximal portion of the legs reddish, head less hairy, and abdomen comparatively strongly punctate."

At present it does not appear possible to separate the early stages of this group of species. While there are obscure differences, there do not appear to be the necessary positive ones.

The Egg. (Pl. I., Fig. 2.)

Length, 3 mm.; width, 0.6 mm.; slightly reniform, of a creamy white color, without perceivable reticulations.

The Larva. (Pl. I., Fig. 3.)

Length, 14 mm. Head much smaller than thoracic segments, body decreasing in width posteriorly with moderate uniformity to the eighth segment, which is considerably smaller, the anal still more reduced; body light straw-color, the two posterior segments lighter; head anteriorly dark brown, posteriorly the color of the body, mandibles darker than anterior portion of head. Cervical shield brownish yellow, anterior surface smooth polished, terminating posteriorly in a slightly raised, transverse ridge. The apical declivity is shagreened, more finely posteriorly.

only and centrally; narrow median dorsal area whiter; lateral oblique, sinuate grooves darker. In front of the shagreened area are a few short erect hairs, with larger ones placed laterally on this segment. On the next segment there are but two lateral hairs on each side, and none on other segments until the eleventh, which has a single stout bristle on each side considerably above the margin, and a transverse row of hairs along the posterior margin. The anal segment has a considerable number of long curved hairs along the lateral and posterior areas. The lateral margins of each of the abdominal segments, just below the spiracles, have an inflated appearance, and segments three to ten inclusive are strongly sculptured, especially on the dorsal surface, by transverse, tubercular, flattened ridges which are minutely shagreened. The sculpture of these is clearly shown in Fig. 3, Pl. I. The lateral inflations, with deep intervening constrictions, give the larva when extended a somewhat moniliform aspect.

The Pupa. (Pl. I., Fig. 4.)

Length, 13 mm.; color uniformly light yellow; head with nearly triangular impressed area between the bases of the antennæ, on each side of which are a pair of closely set hairs. There are two clusters of minute spinules on the clypeus. The antennæ, being abruptly bent downward, give the head a decidedly square appearance. They extend backward to just beyond the middle femora, where they turn forward along and outside of the anterior and middle legs, the posterior pair of legs being folded under the wings. There is a minute, robust, hooked spine on the marginal ridge of each of the abdominal segments except the terminal, the hooks being reversed; there is also on each of these segments a transverse dorsal elevation armed with irregularly placed, minute, stout spines. The terminal segment is provided with a number of long hairs.

LIFE HISTORY.

There is a single annual generation, the larvæ hibernating in the twigs and finishing their development in the spring, the

larval period being nearly eleven months. Pupation takes place within the twigs during late April and early May, the pupal period occupying from 22 to 29 days. The eggs are deposited, in the vicinity of lat. 40°, in Illinois, from about May 20 to June 15. The egg period is from 5 to 7 days.

METHOD OF OVIPOSITION.

As observed by Mr. Titus, the female first girdles the tender growing twig by cutting, with her jaws, a deep groove entirely around it. The twig is then easily detached, and falls to the ground with the first light breeze that occurs. Retreating about an inch along the remaining portion of the twig, the beetle cuts a short longitudinal slit in and through the bark but not entering the wood, and at the lower end of this she cuts a shorter transverse gash, also extending only through the bark. She now pushes the tip of her abdomen under the bark at the angle formed by the two gashes she has made, usually to the right of the longitudinal slit but sometimes to the left, and places her egg snugly under the young tender bark, sometimes nearly a fourth of the way around the twig, where it can be easily detected by the slight elevation thus caused. Having placed her egg, she now retreats still further toward the base of the twig, usually about an inch, and here girdles it a second time, but cutting only to the wood, thus crippling the twig without killing it. If the same female deposits more than one egg in the same twig, she does it at different times, the evident intention being to place them singly, one in each twig, and as shown in Plate I., Fig. 2.

HABITS OF THE LARVA.

The young larva, on first hatching from the egg, begins to feed even before it has entirely emerged, gnawing a minute channel toward the base of the twig and under the bark long enough to enable it wholly to withdraw the body from the egg-shell. It then seems to back up into the abandoned shell and cuts a minute circular hole in the bark directly in line with the channel. Up to this time all of the castings have been pushed

back into the egg-shell, but now they are pushed out through the circular hole thus made. Working now down the center of the twig and continually enlarging its burrow, the larva provides at intervals similar but larger vents in the walls for the same purpose. In this species these holes for the disposal of excreta and waste material do not appear to be as frequently cut as in the case of allied species, the distance from one to another ranging in our specimens from a little over an inch to more than two inches.

Several years ago, while studying similar habits of what I then supposed to be *Oberea bimaculata*, but now know to have been *O. tripunctata*, I observed these holes to occur frequently not more than an inch apart, and the excreta were pushed through and fell down in more or less continuous sections. In two cases the masses of excreta thus disposed of by a larva of that species nearly full grown and about an inch in length during the twenty-four hours, were kept and carefully measured. Their length amounted to the astounding total of twenty-four and three eighths inches, showing that each hour of the day and night the larva had voided a stool greater than its own length,—a fact which gives some idea of the enormous amount of food eaten within that time.*

As the larva increases in size it frequently reverses its position in its burrow, and moves up and down at will. These journeys are easily accomplished by the simple contraction and expansion of the segments of its body aided by the shagreened areas on the dorsal surface. Just prior to pupation, the larva gnaws out a cavity in the wall of its burrow similar to that constructed for the disposal of the excreta, except that it does not penetrate the outer bark. An avenue of escape is thus provided for the adult beetle without exposing the pupa. Pupation occurs within the burrow, and only a few minutes are required for the escape of the beetle from the pupal envelope.

Secure as they may appear to be in their channels, the larvæ are not without their troubles, for not only the main

*Journ. N. Y. Ent. Soc., Vol. V., pp. 202-203, Pl. X., Fig. 1 and 2.

twig is inhabited but the laterals as well, and there may thus be several larvæ, each in its individual twig, pushing downward to the base, in which but one of them can survive. The one that is foremost in this blind race, as it passes below its fellows cuts off their food supply and leaves them to perish in their homes. In some instances larvæ have been observed to pass the whole length of water-shoots and for a short distance into the wood of the tree itself.

The effect on the trees is to destroy the growth of shoots put forth prior to the middle of June. This injury, continued year after year, results in bunches of dead stubs, a clump of which is shown in the colored plate (II.), drawn from a specimen cut by me from a tree in one of the parks in Decatur. The short blackened stub to the right shows the work of the larvæ two years ago; the longer one to the right of it, with the two blackened laterals, shows the work last year; while the green and brown shoots show the effect on the twigs the present season. The single small twig at the extreme right, which sprang out from the base of a larger one already affected, was the only one of the cluster that had escaped destruction, it having been put forth after the beetles had disappeared. By another year this whole group of twigs would have become hollow blackened stubs. Fresh growths being attacked and destroyed in the same manner, the cluster of dead stubs is increased year after year. In such a case as that of the uninjured twig at the extreme right in the colored plate, the larva would continue its work another spring and, passing below the juncture, finish the destruction of the group.

HABITS OF THE ADULT INSECT.

Two very striking peculiarities were observed by both Mr. Titus and myself. In the twenty-five years that I have been studying the habits of insects, I do not recall an instance of such seemingly utter disregard for the perpetuation of the species as is exhibited by these beetles. The vicious assaults which they make on each other, regardless of sex, are paralleled only among the *Mantide* and some species of spiders. While I

did not notice any conflicts in the open, we both experienced the utmost difficulty in keeping the adults in sufficiently close quarters to enable us to study their actions. If a male and female were confined at all closely, they would instantly attack each other with such ferocity that within a few moments they would be rolling helplessly about among fragments of legs and antennæ, only the basal portions of these remaining attached to their bodies. It was found wholly impossible to transport living individuals without giving them ample quarters, and I was finally forced to give each a box or vial to itself.

The other peculiarity referred to is a lack or insufficiency of the dispersal instinct when the beetles become excessively abundant in a locality. Though no trace of them was found in some parts of the city of Decatur, in other parts they were so abundant that the young growth of the elm did not afford them sufficient material in which to mature more than a small percentage of their larvæ, only one of which can develop in a single twig, but instead of hunting for other trees where suitable conditions existed, the females girdled the twigs and deposited the egg where this had been done, not only once, but time and time again, before. I have found twigs in which there had been as many as eight separate ovipositions, with the usual number of girdlings in each case.

The upper figure in the colored plate affords a very good illustration of a multiplicity of ovipositions, as also one of the twigs in the cluster below. We have here, consequently, what might almost be termed insect infanticide on a stupendous scale. But the full extent of this wholesale murder does not appear in the illustrations. In all examinations of the amputated portions of the twigs made by Mr. Titus, he found none which contained eggs or larvæ, and this was true of my own observations, made during the early part of the egg-laying season. Late in May, however, I began to find sections of amputated twigs on the ground underneath the trees, which showed plainly that this amputation was not the result of a first visit of a female intent on oviposition. Ordinarily, the tip of the twig is severed far

enough back to include from two to four or five leaves, and this amputated portion is free from egg or larva. But I now began to find, scattered under the infested trees, pieces of twigs which had been cut off at both ends, and those freshly dropped contained in most cases either an egg or a newly hatched larva, while in the older, withered ones there was more often a very young larva, dead. As the season of oviposition advanced, these secondary amputations, repeated perhaps five or six times on the same twig, became more numerous, and an examination of the trees disclosed the fact that nearly every twig contained at least one egg or larva, and that some of them contained several. For those females that had yet to oviposit, there were no twigs not preoccupied, and fully five per cent. of the amputated pieces on the ground contained a larva or an egg. It became clear that the mortality resulting from this repeated oviposition and amputation was greater than that from all other causes combined.

The beetles appear to feed but little, and then only on the leaf veins, as shown in Fig. 5, Plate I., and at the extreme right of the colored plate. Neither Mr. Titus nor myself found them feeding on any other part of the leaf, or any indication of their having done so, even when confined in breeding-cages.

FOOD PLANTS.

It would seem from the information thus far obtained, that this species confines itself strictly to the American elm. While the beetles will, if confined on other plants exclusively, feed sparingly on the leaves, they will not oviposit in the twigs, but if removed and placed on elm, they will proceed to deposit their eggs. Adults of both sexes confined on raspberry May 20, were all dead by May 29, having in the mean time shown no inclination whatever to oviposit, though the sexes were observed in the act of pairing. The same was true of those confined on *Cornus*; but when removed, these females oviposited in elm. These statements are taken from Mr. Titus's notes, and my own experiments simply duplicated these results. Though I found *Oberea* larvæ in other kinds of trees in the parks at Decatur, I am confident that these belonged to another species, probably *Oberea*

tripunctata, which was also reared from elm-trees infested by *ulmicola*. No experiments were tried with other species of elm.

NATURAL ENEMIES.

As may be seen from the foregoing, this species is its own greatest enemy. No egg parasites have been found, though such may confidently be looked for in the future. That the eggs are to some extent destroyed by birds, appears probable, though none were observed in the act. Nuthatches were present in the trees, both in those infested and in those free from the pest, and the frequent occurrence of twigs with the bark pushed upward and outward at the point where the egg is usually placed, as is shown in Plate II., upper figure, suggests clearly that some feathered enemy had pushed its beak beneath. As this lifting of the bark was noticed only on the side of the longitudinal slit where the egg is usually placed, it is fair to presume that either the egg or young larva had been removed.

GENERAL EFFECT ON ELM-TREES.

The production of bunches of short twigs which are annually killed and replaced by others, these suffering in turn in the same manner, has been already described, and the inevitable effect on the general appearance of the trees will be clear to any one at all familiar with the growth of young elms. They gradually assume a scraggy, stunted, and misshapen appearance, with the foliage inclined to grow in tufts about the larger limbs, the latter throwing up an unusually large number of water-shoots, which, being killed down each year, add to the unsightly appearance of the tree. The limbs may increase in size but not in length, as each year's growth is killed back the same year. Sometimes the larvæ working in spring pass beyond into lateral twigs which had escaped attack and cause their death. I have found lateral twigs and fresh growths withering and dying from this cause as late as the latter part of May. Larger trees do not show the injury as much as smaller ones, but even the former will lack the broad, wide-spreading growth so much admired in the elm. Not all trees standing in

close proximity are affected alike. Some will be girdled comparatively little, while others, perhaps but a few rods away, will suffer a most serious pruning. It would seem as though the beetles were disinclined to forsake the trees from which they had themselves emerged,—a supposition strongly supported by their extremely local distribution.

DISCOVERY OF THE SPECIES.

The attention of the custodian of the Decatur city park was first attracted to the insect by the enormous dropping of the leaves during late May and June, this increasing the labor required to keep the grounds in proper condition. The facts were first reported to the State Entomologist in October, 1901, at which time it was said that the injury had been noticed for some two or three years preceding, becoming more serious each year. The tips of the twigs, with from three to six leaves attached, appeared to have been cut squarely off in a way to suggest the work of an insect, but of the author of the injury itself nothing had then been learned. May 23, 1902, Mr. Titus was sent to Decatur by Professor Forbes to learn the cause of the injury, and it was during this visit that he first secured material for his studies of the habits and life history of the species. This was supplemented by further accessions from the trees during the remainder of the season, and by carrying the females with him, in his travels about the state, Mr. Titus was enabled to secure the facts here given relative to oviposition and to the actions of the very young larva. Other data were obtained by carrying the insect through the year in the insectary. The writer took up the investigation in the spring of 1903, and was able to add somewhat to the results of the careful work of Mr. Titus, as well as to clear up some points on which the latter had not been able to secure conclusive evidence.

EXPLANATION OF PLATES.

PLATE I.

The Elm Twig-girdler, *Oberea ulmicola* Chittenden: a, adult beetle; b, egg, enlarged and in position under bark of twig; c, larva, d, pupa, e, showing leaf-veins eaten out by beetle in feeding.

PLATE II.

Elm Twig-girdler, *Oberea ulmicola* Chittenden; a, illustrating girdling of twigs by adult and the general effect on the young twigs, the original having been cut from an elm-tree in a city park in Decatur, Ill.; adult shown engaged in feeding on leaf at right; b, a much girdled twig illustrating the effect of birds in searching for eggs or young larvæ.